FAA-E-2644
September 15, 1975

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

AUDIO OSCILLATOR AND IDENTIFICATION KEYER

1. SCOPE

1.1 Scope.- The equipment specified herein is a combined solid state 1020 Hz audio oscillator and identification keyer for International Morse Code identification keying of navigational aid transmitters. The equipment provides a keyed 1020 Hz output signal for identification of a VOR or ILS localizer transmitter and keyed contact closure for the synchronous keying of an associated TACAN or DME transponder.

2. APPLICABLE SPECIFICATIONS

2.1 Specifications issue.- The following specifications of the issues specified in invitation for bids or request for proposals form a part of this specification, and are applicable in their entirety except as specifically modified herein after.

2.1.1 FAA specifications.-

FAA-G-2100/1	Electronic Equipment, General Specification
FAA-G-2100/3	Requirements for Equipment Employing Semiconductor Devices
FAA-G-2100/4	Requirements for Equipment Employing Printed Wiring Techniques

FAA-G-2100/5 Requirements for Equipment Employing Micro-electronic Devices

FAA-G-2300 Panel and Vertical Chassis, Rack

FAA-D-2494/1 Instruction Book Manuscript Technical: Equipment and Systems Requirements Part 1, Preparation of Manuscript

FAA-D-2494/2 Instruction Book Manuscript Technical: Equipment and Systems Requirements Part 2, Preparation of Manuscript Copy and Reproducible Artwork

(Copies of this specification, and of other applicable FAA specifications, may be obtained from: Federal Aviation Administration, Washington, D. C. 20591, ATTN: Contracting Officer. Requests should fully identify material desired, i.e., specifications numbers, dates, amendment numbers, complete drawing numbers; also requests should identify the Invitation for Bid, Request for Proposal or Contract involved or other use to be made of the requested material.)

2.1.2 MIL Standard and specifications.-

MIL-E-17555 Electronic and Electrical Equipment, Accessories and Repair Parts; Packing and Packing of

MIL-STD-471 Maintainability Demonstration

MIL-STD-781 Reliability Test, Exponential Distribution

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- Each audio oscillator and identification keyer furnished by the contractor shall be complete in accordance with all specification requirements.

Any feature or item necessary for proper operation in accordance with the requirements of this specification shall be incorporated even though that feature or item may not be specifically described herein. Instruction book material shall be furnished in accordance with FAA-D-2494/1 and FAA-D-2494/2 in quantities specified in the contract schedule.

3.2 Definitions

3.2.1 Hum distortion frequency.- A hum distortion frequency is defined as the fundamental (or any harmonic) of the AC line frequency, excluding the 1020 Hz oscillator fundamental frequency.

3.3 General Functional requirements.- The equipment is required to be an exact physical and electrical replacement for existing oscillator-keyers. Major requirements are high reliability and stability under continuous unattended operation, ease of adjustment and minimum maintenance. The keyed Morse Code 1020 Hz output and synchronous continuity keying for TACAN or DME are the major functions of the equipment.

3.4 Service conditions.- The service conditions shall be those of paragraph 1-3.2.23, FAA-G-2100/1 with the ambient conditions of ENVIRONMENT II thereof.

3.5 Power source.- The equipment shall operate from single phase, 120V, or 240V 60 Hz (design center values, 1-3.2.21, FAA-G-2100/1) two-wire AC line (with ground) power source.

3.6 Electronic devices.- All active devices shall be semiconductor devices in accordance with FAA-G-2100/3 or micro-electronic devices in accordance with FAA-G-2100/5. Tubes shall not be employed. The use of electro-mechanical devices shall be confined to high reliability mercury wetted contact relays.

3.7 Modular construction.- Modular construction with plug-in or easily replacable subassemblies shall be employed throughout the equipment in order to provide the specified repair capabilities of paragraph 3.13a. Modularization shall be based on logical functional block concept. Design shall be such as to minimize the average cost and number of different types of modules required for supply support.

3.7.1 Printed wiring boards.- Except for controls and components specified to be located elsewhere, or where demonstrated to be impractical from the standpoint of parts size or weight, all circuit parts shall be mounted on printed wiring boards in accordance with FAA-G-2100/4. All boards shall be of the plug-in type with suitable metal or thermosetting plastic guides and shall be keyed such that they can be inserted only in the correct receptacle and in the correct orientation for proper circuit connection. Handles shall be provided on all boards to facilitate removal. In lieu of handles, a board extractor may be provided in a suitable storage space within the equipment. Where necessary to provide unrestricted access to all components for trouble shooting purposes, board extender(s) shall be furnished in a suitable space within the equipment.

3.7.2 Chassis-type modules.- Where it is demonstrated that printed wiring boards (3.7.1) are impractical, chassis type modules shall be utilized. Chassis type modules shall be plug-in. Where necessary to provide unrestricted access to all components for trouble-shooting purposes, extender cables(s) shall be furnished. A minimum of one extender cable of each type required shall be furnished in a suitable storage space within the equipment.

3.7.3 Accessibility.- Normal functional checks of the equipment shall be possible through the provision of significant test points, or other means which are readily accessible without resort to extender, thereby allowing testing without interruption of operation.

3.8 Equipment construction.- The equipment shall be constructed for mounting in a standard equipment cabinet rack (not required to be furnished under this specification). Materials and workmanship shall conform to Specification FAA-G-2300. The chassis shall be designed such that its overall depth behind the front panel does not exceed 14 3/4 inches. The chassis shall mount on a front panel, size "D" (Drawing D-21140D of FAA-G-2300). The front panel shall in all other respects conform to Drawing D-21342H of FAA-G-2300. The front panel finish shall be black wrinkle (modifies 1-3.8.2 of FAA-G-2100/1).

3.8.1 Terminal block.- A block having 15 terminals shall be provided and mounted vertically on the right rear of the chassis (when viewed from the rear). The terminal block shall be H. B. Jones Division, Cinch Mfg. Corp. 164-Y, General Products Corp., GEN-PRO 464Y, or equal. Terminal designations and the sequence of terminals from top to bottom shall be as follows:

1	1020 Hz output
2	1020 Hz output
3	N/C
4	N/C
5	N/C
6	N/C
7	N/C
8	N/C
9	N/C
10	N/C
11	N/C
12	N/C
13	TACAN/DME IDENT (common)
14	TACAN/DME IDENT (continuity)
15	TACAN/DME IDENT (keyed)

3.9 Audio oscillator.- The audio oscillator shall meet the requirements of the following subparagraphs.

3.9.1 Oscillator frequency.- At the option of the equipment contractor, the audio oscillator may be either of the tunable frequency or fixed frequency type. The tunable frequency oscillator shall be capable of adjustment to within 1.0 Hz of 1020.0 Hz and shall have a stability of $\pm$5.0 Hz over the range of service conditions. If the contractor elects to provide a non-adjustable oscillator, the precision and stability shall be such as to provide an output frequency of 1020.0 $\pm$1.0 Hz over the range of environmental and long term variation. A type BNC test jack within the equipment, accessible from the front of the equipment shall provide an unkeyed output of not less than 0.25 volts RMS when loaded by 1.0 megohm. Shorting the test jack shall not disrupt normal operation.

3.9.2 Output circuit.- The output circuit shall meet the requirements of the following subparagraphs. The balanced ungrounded output shall be present on rear terminals.

3.9.2.1 Output load.- All specification requirements shall be met when a 600 ohm ± 10% resistive load is connected to the oscillator output.

3.9.2.2 Output level adjustment.- A control shall be provided within the equipment to allow continuous adjustment of the audio output level from -20 dBm, or less, to +15 dBm, or greater.

3.9.3 Noise level.- The noise level shall not exceed -50 dBm at every position of the output level control.

3.9.4 Distortion.- The total harmonic distortion shall not exceed 2% at any setting of the output level control (3.9.2.2).

3.9.5 Hum distortion.- At every position of the output level control the root sum square of the amplitudes of all hum distortion frequencies shall not exceed -46 dBm.

3.10 Identification Keyer.- The keyer shall meet the requirements of the following subparagraphs.

3.10.1 International Morse Code Characters.- The keyer shall be capable of being programmed with ordinary hand tools using links within ten minutes to provide any three or four letters (A through Z) plus a space between each letter equal to three dot lengths (3.10.2). It shall be possible to program a space between the second and third letter equal to five dot lengths (3.10.2) when three letters are programmed or between the third and fourth letters when four letters are programmed. When four letters are programmed the first letter will be the letter "I".

3.10.2 Dot length.- The length of a dot shall be continuously adjustable from 100 milliseconds or less to 140 milliseconds or more, but under no condition shall the range be adjustable to less than 85 milliseconds nor more than 155 milliseconds. The control shall be placed within the equipment.

3.10.2.1 Length stability.- The length of a dot shall not vary by more than ±5 millisecond over the service conditions for any setting of the dot length control (3.10.2).

3.10.3 Dash length.- The length of the dash shall be equal to three dot lengths (3.10.2).

3.10.4 Space between letter elements.- The space between letter elements shall be equal to one dot length (3.10.2), except as specified in paragraph 3.10.1.

3.10.5 Keyer cycle timing.- The timing 1020 Hz identification shall be repeated at intervals equal to sixty-four (64) dot lengths.

3.10.5.1 TACAN/DME Keying input.- (Reference Figure 1.) Provision shall be provided for simple programming of synchronous keying of an associated DME (or TACAN) equipment (not required to be furnished under this specification). When TACAN/DME identification is desired, every fourth identification cycle of 1020 Hz keyed ident shall be omitted, and presented instead in the form of continuity keying of the TACAN/DME output terminals. Thus the TACAN/DME will be keyed with one cycle of Morse Code Identification once every 256 dot lengths. Simple switching shall enable "VOR only" operation that shall cause the TACAN/DME cycle to be replaced by the 1020 Hz keying cycle (3.10.5).

3.10.5.1.1 TACAN/DME output circuit.- The output terminals of the TACAN/DME circuit shall be open when not keyed. An open circuit voltage presented from external equipment (not to be furnished under this contract) that will appear across the terminals will be up to 55 VDC. The current through the circuit when keyed will not exceed 100 MA, under which conditions the voltage drop across the terminals shall not exceed 1.0 volt. DME keying shall not be affected by operation of the 1020 Hz keyer selector switch (3.10.8).

3.10.5.1.2 TACAN cycle output.- During the TACAN/DME cycle, a set of contacts connected to the terminal block (3.8.1) that are normally closed, shall be opened, and remain open for duration of the TACAN Keying cycle.

3.10.6 Keying transients.- Keying pulses shall start without undesirable transients, shall have no discontinuities, and shall stop without undesirable transients. Transient peaks due to keying shall not exceed 5 percent of the peak amplitude of the audio frequency waveform.

3.10.7 Keyer leakage.- When the keyer is in the unkeyed position, the residual audio (total hum, noise, and 1020 Hz) shall not exceed -50 dBm at the 1020 Hz output terminals.

3.10.8 Keyer switch.- A three-position switch shall be provided on the front panel. Position 1 shall remove 1020 Hz keyed ident from the output terminals. Position 2 shall provide unkeyed 1020 Hz to the output terminals. Position 3 shall provide keyed 1020 Hz to the output terminals.

3.11 Corrective maintenance.- The supplier of equipment to this specification is concurrently required to develop corrective maintenance procedures for the equipment, as for equipment maintenance manuals or in conjunction with a maintainability program (3.13). Such procedures shall be capable of accomplishment using only the test equipment listed hereunder.

(a) VTVM, HP Model 410B, or equal
(b) Volt-Ohmeter, Tripplett 630NA, or equal
(c) Oscilloscope, DC to 100 kHz, Dumont Model 255 or equal
(d) Audio oscillator, HP Model 200 AB, or equal
(e) Digital frequency counter, 0 to 1.0 MHz.

3.12 Reliability program.- The contractor shall conduct a reliability program as described in 1-3.19 of FAA-G-2100/1. The specified mean time between failure (MTBF) for the equipment operating in a keyed condition, and with TACAN/DME keying, shall be 12,000 hours.

3.13 Maintainability program.- The contractor shall conduct a maintainability program as described in 1-3.20 of FAA-G-2100/1. The program shall include a demonstration phase (4.6) and shall establish that the following requirements are met:

(a) The mean time to repair (MTTR) shall not be more than 20 minutes. In addition, not more than ten percent of all repairs shall exceed 30 minutes, and no single repair shall require more than 60 minutes.

(b) The preventive maintenance time (MPMT) shall not exceed 20 minutes in 12,000 hours of operation.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- Section 1-4 of FAA-G-2100/1 shall apply. Unless otherwise specified each equipment shall be tested with the 1020 Hz keyed and with DME keying. In the interest of expediting completion of design qualification test (4.2), reliability demonstration (4.5), and maintainability demonstration (4.6), such tests may be conducted concurrently on the first ten (10) production equipments (modifies 1-4.3.2 and Type-Test Groups I and II of Table I of FAA-G-2100/1).

4.2 Design qualification tests.- (See also 1-4.3.2 of FAA-G-2100.)

4.2.1 Normal test conditions.- The following design qualification tests shall be conducted under normal test conditions.

Test	Paragraph
Dot length	3.10.2
Dash length	3.10.3
Keyer cycle timing	3.10.5
TACAN/DME keying output	3.10.5.1
TACAN/DME output circuit	3.10.5.1.1
TACAN cycle output	3.10.5.1.2
Keying transients	3.10.6

4.2.2 Service conditions.- These tests shall be identical to those of 4.3.2, service condition, type test. The code to be used is IXDZ.

4.3 Type tests.- The following test shall be conducted with the identification code assigned for the equipment selected.

4.3.1 Normal test conditions.- The following test shall be conducted under normal test conditions.

Test	Paragraph
Oscillator frequency	3.9.1
Keying transients	3.10.6

4.3.2 Service conditions.- The following type test shall be made while subjecting the equipment to the test procedure described under 1-4.12 of FAA-G-2100/1. The test shall be conducted with the oscillator/keyer adjusted for keyed 1020 Hz output and DME keying of the assigned code for the equipment selected. Test marked by asterisk (*) shall be performed at 102, 120, 138, 204, 240, and 276 VAC line voltage input.

Test	Paragraph
Audio Oscillator frequency*	3.9.1
Output stability*	3.9.2.3
Noise level	3.9.3
Distortion	3.9.4
Hum distortion*	3.9.5
Dot length stability	3.10.2.1
Keyer leakage	3.10.6

4.4 Production tests.- The following production test shall be made.

Test	Paragraph
Oscillator frequency	3.9.1
Output level adjustment	3.9.2.2
Keyer switch	3.10.8

4.5 Reliability demonstration test plan.- The reliability demonstration test plan shall be Test Plan XXV, of MIL-STD-781. The test shall be conducted under normal test conditions with daily line voltage variation and daily "on-off" switching.

4.6 Maintainability demonstration test plan.- The contractor shall design and implement a maintainability demonstration plan such that the probability of the Government accepting an equipment that does not meet MTTR and MPMT requirements does not exceed 0.1. The contractor shall design plans whereunder fault simulation for corrective maintenance tasks shall be performed by the introduction of faulty parts, deliberate misalignment and "bugging" as specified in MIL-STD-471. Preventive maintenance will not be charged against MTTR. Further, the contractor may assume that time-to-repair data will not include logistic delay, i.e., maintenance personnel, parts and tools are available at the site. The contractor shall demonstrate MTTR (corrective maintenance) by applying method 4 (90 percent confidence) from MIL-STD-471 using the fault simulation time-to-repair data.

5. PREPARATION FOR DELIVERY

5.1 General.- Unless otherwise specified in the contract, the equipment shall be prepared for domestic shipment in accordance with the following subparagraphs.

5.2 Preservation and packaging.- Preservation and packaging shall be in accordance with Specification MIL-E-17555, Level A.

5.3 Packing.- Packing shall be in accordance with Specification MIL-E-17555, Level B. No more than one oscillator/keyer and associated items shall be packed in each shipping container.

5.4 Marking.- Each package and shipping container shall be durably and legibly marked with the following information.

Name and Item of FA Designation
Serial Number
Quantity
Contract Number
National Stock Number
Gross Weigth of Container
Manufacturer's Name

6. NOTES

6.1 Functional block diagram.- Figure One is furnished only as a matter of information to the contractor to assist him in visualizing a typical deisgn.

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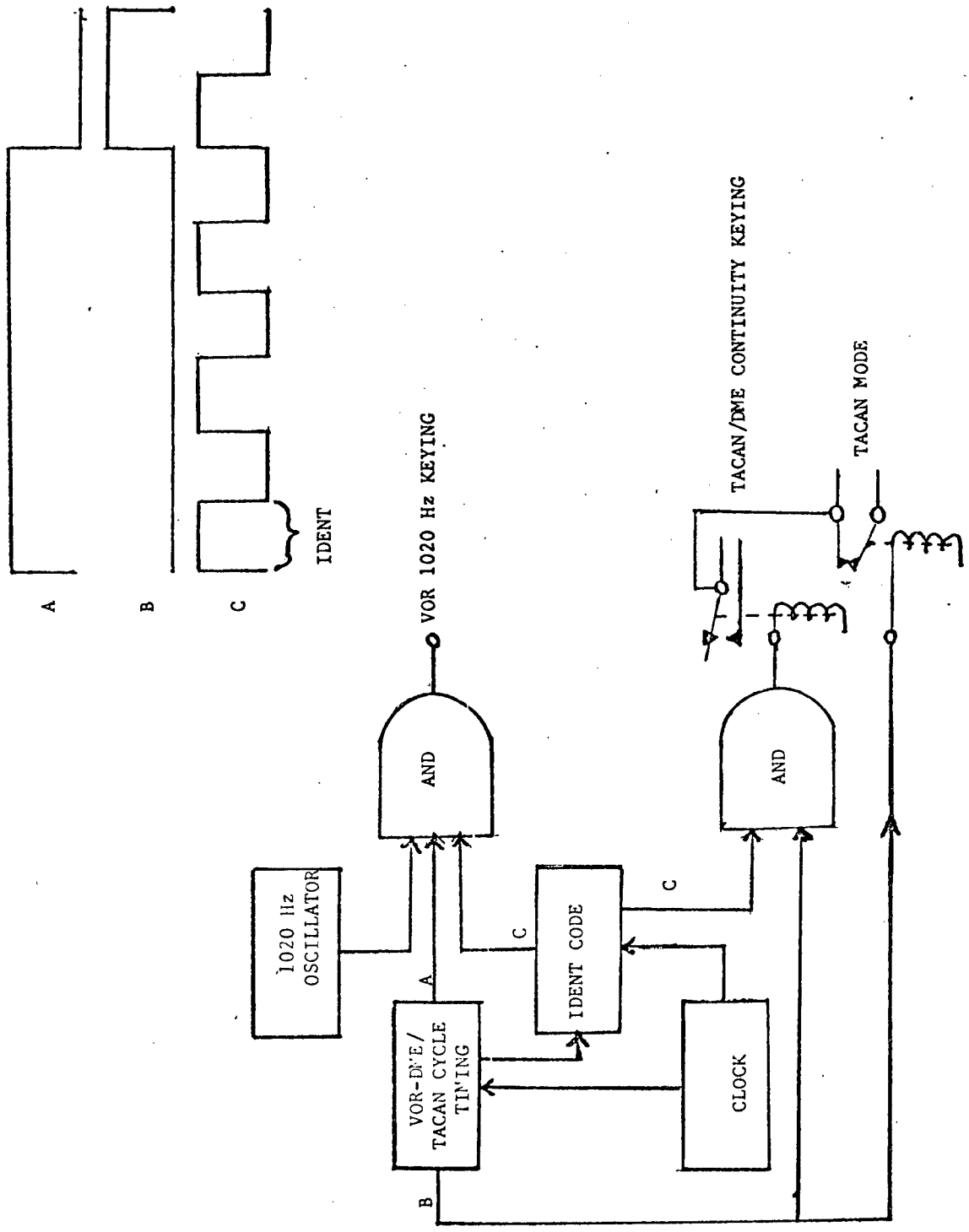

FIGURE 1 - FUNCTIONAL BLOCK DIAGRAM
OSCILLATOR-KEYER